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Plasmonic color filters fabricated by soft-X-ray lithography

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Abstract: Soft-X-ray lithography has emerged as a newly technique for manufacturing nanopatterns with both high precision and throughput. Here, we utilize four-beam interference lithography and achromatic Talbot lithography to fabricate high-resolution, and large-area color filters.

Conventional top-down lithography techniques with high resolution, such as EBL and FIB, are low-throughput, which restrict large-area fabrication for industrial applications. Recently, soft-X-ray lithography with high resolution, strong exposure intensity and excellent coherence has generated considerable intertest as a promising technique for manufacturing nanopatterns with both high precision and throughput. Here we utilize four-beam interference lithography [1] and achromatic Talbot lithography (ATL) [2], by utilizing soft-X-ray interference lithography to achieve stitching nano-patterns and fast fabrication of large-area color filters. The samples are mainly prepared at the Soft-X-Ray Interference Lithography Beamline (BL08U1B) in Shanghai Synchrotron Radiation Facility (SSRF).

Four gold gratings were used as the mask of four-beam interference lithography. Nanodot arrays were realized via the first order interference of four-beam Soft-X-Ray. In order to obstruct the zeroth order, an order sorting aperture (OSA) was placed closely but disconnectedly in front of wafer. The large-area manufacturing of nano-cylinder arrays was achieved by stitching multiple exposure fields. Fig. 1 (a) shows the scheme of four-beam interference lithography. Fig. 1 (c) shows the color filter sample with the period of 230 nm fabricated by four-beam interference lithography whose area is 4 x 4 mm^2 and its optical micrograph and SEM image.

Achromatic Talbot lithography method makes use of Talbot effect, which is a well-known phenomenon in which illuminated objects with periodic transmission profile produce self-images at certain distances. Compared with four-beam interference lithography, a single grating mask is employed in ATL, which simplifies the mask fabrication process, and enables to use full of illuminating area. Fig. 1 (b) shows the schematic illustration of achromatic Talbot lithography. The color filter consists of the silicon substrate, HSQ cylinder and Ag film. Fig. 1 (d) shows the optical micrograph and SEM image of the color filter with the period of 200 nm fabricated by ATL whose area is 0.72 x 0.72 mm^2.

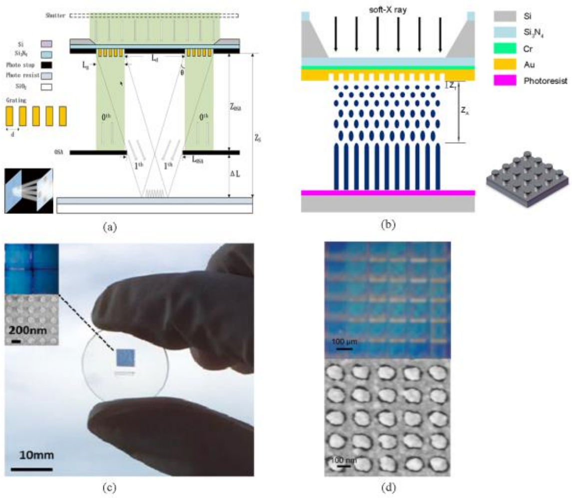

Fig. 1 (a)The scheme of four-beam interference lithography. (b)The scheme of achromatic Talbot lithography. (c) the optical micrograph and SEM image of the color filter with the period of 230 nm fabricated by four-beam interference lithography. (d) the optical micrograph and SEM image of the color filter with the period of 200 nm fabricated by ATL.

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